

AN AUSTRALIAN CARYOPHYLLAEID CESTODE.

By PROFESSOR T. HARVEY JOHNSTON, University of Adelaide.

(Seventeen Text-figures).

[Read 27th August, 1924.]

On several occasions Dr. T. L. and Dr. M. J. Bancroft collected a number of small cestodes from the duodenum of a widely distributed Australian Silurid, the common freshwater jewfish or catfish, *Tandanus tandanus* Mitchell, caught in the Burnett River near Eidsvold, Queensland. These parasites have proved to be the first Caryophyllaeid cestodes recorded as occurring beyond Europe, Asia and North America, and the first members of the family collected from fish other than Cyprinoids. If the genus *Caryophyllaeus* be used in a wide sense, then the name, *C. bancrofti*, n.sp., may be used to designate the new species, but as will be shown below, the worm possesses marked characters which, in the writer's opinion, justify the erection of a new genus to receive it.

The length of preserved specimens measured in formalin, varied from 1.1 to 4.7 mm.; breadth .4 to 1.1 mm. The largest were 4.7 by .8 mm.; 4.6 x 1.0; 4.7 by .9 mm.; and the smallest 1.1 by .4 mm. Worms which were immature, but which possessed complete though small genital organs and vitellaria, measured 1.15 by .45 mm. A few eggs were detected in specimens as small as 2.5 mm. in length, so that considerable growth must occur after sexual maturity has been reached. The dimensions of the parasites depend to some extent on the degree of contraction of the highly muscular body and scolex. The worms are elliptical in cross-section, the transverse diameter being about twice the dorsoventral, though in the posterior region, in the vicinity of the ovary and cirrus sac, the body is rather more rounded in section, the dorsoventral diameter then being about two-thirds of the transverse.

The body surface of preserved material is traversed by many more or less transverse folds or grooves owing to the contraction of the longitudinal musculature. There may also be a more or less prominent longitudinal groove extending backwardly from the scolex for a varying distance, but it is not a constant feature.

The scolex is generally markedly broader than the succeeding neck region, and is usually a little wider than the broadest part of the body, which is in the posterior half. No definite sucking grooves, like those of *Archigetes* or *Glaridacris*, occur, nor is the organ leaf-like as in *Caryophyllaeus*. The anterior part is a short rounded cone and is succeeded (in preserved specimens) by a prominent "frill," constituting the widest region of the scolex. The latter at the "frill"

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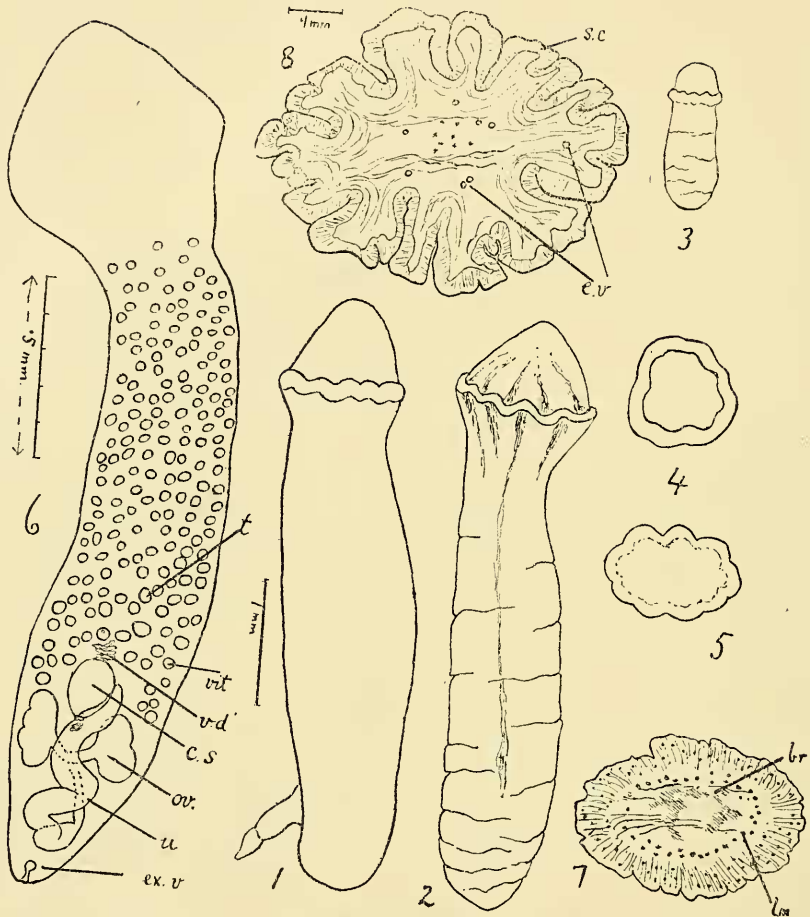
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Figs. 1-8. *Balanotaenia bancrofti*, n.gen. et. sp.

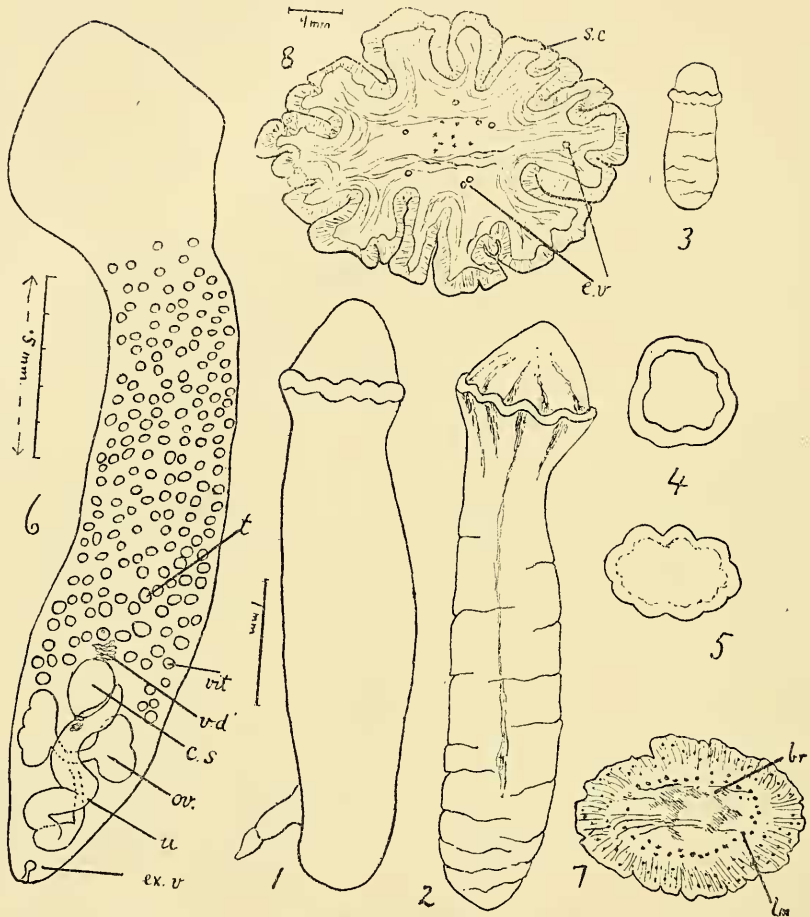
1. Lateral view of adult with extruded cirrus. 2. Ventral view of adult. 3. Smallest specimen observed, 1.1 mm. by .4 mm. (in formalin). 4, 5. End views of scoleces (in formalin). 6. General view (dorsal); stained preparation, somewhat compressed. 7. Transverse section of anterior part of scolex in region of brain. 8. Transverse section in region of "frill"; note deeply folded surface.

Figs. 1 to 5 have been drawn to the scale indicated beside Fig. 1.

Figs. 7 and 8 drawn to scale beside Fig. 8.

All figures have been drawn with the aid of a camera lucida.

References to Lettering:—br., brain; c.s., cirrus sac; cu., cuticle; e., egg; c.v., excretory vessel; ex.v., excretory vesicle; f., "frill"; g.a., genital atrium; g.u., glandular uterus; l.m., longitudinal muscles; m., muscles; n., nerve; od., oviduct; o.i., ovarian isthmus; ov., ovary; r.s., receptaculum seminis; s.c., subcuticula; s.g., shell gland; t., testis; t.m., transverse muscle fibres; u., uterus; u.a., uterine opening into genital atrium; u.c., uterine cavity; u.d., uterine duct; v., vagina; v.d., vas deferens or vesicula seminalis; vit., vitelline follicle; vit.d., vitelline duct.



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may vary in size as the following measurements of large parasites show:— .7 mm. across by .5 mm. in thickness; 1.1 by .75; .85 by .85 mm. In life this part is probably highly mobile, but in the material examined it appeared as a thick muscular projecting fold exhibiting an undulating edge, the depressions or grooves between the rounded edges being sometimes comparatively deep and extending anteriorly as well as posteriorly into the neck. These ridges are variable in number, though in most specimens examined about ten were present. This expanded portion is abundantly supplied with muscle fibres inserted into it. The scolex narrows somewhat posteriorly, but a distinct neck region is hardly recognisable since the most anterior vitelline follicles lie very close behind the "frill."

The position of the sex openings seems to vary with the degree of contraction of the parasite, but is always near the posterior end. The genital atrium, into which the vagina and uterus open, is a more or less narrow transversely elongate slit, commonly crescentic, situated ventrally in the vicinity of the ovarian isthmus. The male aperture is included within the atrium when the cirrus is at rest. In a worm 4.5 mm. long the atrium was situated at .5 mm. from the posterior end, i.e., at one-ninth the body length; in another (4 mm. long) at one-seventh; in another (2.7 mm. long) at one-eighth; in another (2.4 mm. long) at one-seventh; and in another (3 mm. long) at one-twelfth the total body length from the posterior extremity.

The smooth cuticle, 4 to 7 μ thick, is succeeded by a definite basement membrane. The subcuticula occupies a wide zone and consists of rather closely arranged narrow elongate cells with prominent nuclei situated at different levels. There is a ring of delicate longitudinal muscle fibres just below the basement membrane. Calcareous corpuscles are absent.

The main longitudinal series of muscle fibres is almost central, forming a well-defined zone inwardly from the testes and vitellaria, but in the posterior region of the worm the system is feebly developed. The central portion of the zone is occupied by parenchyma traversed by comparatively few transverse fibres and by very few dorsoventral fibres. There is no tendency for the longitudinal fibres to become aggregated into bundles, except in the anterior part of the scolex, where such are very small and numerous. Passing outwardly from the main musculature, there are seen in sections abundant fibres traversing the region between the testes and between the vitellaria to reach the subcuticula. In the posterior part of the scolex, the longitudinal muscles occupy a very considerable region of the parenchyma, forming a wide elliptical zone within which are transverse fibres. The arrangement of the longitudinal musculature is thus characteristic in that it occupies a well-defined region between the dorsal and ventral testes, instead of the position usually met with, outwardly from the vitelline region.

The nervous system is generally ill-defined. The main longitudinal nerve lies in the parenchyma near the inner ends of the laterally placed vitellaria. In the region of the ovary it is dorsolateral to the corresponding ovarian lobe. In the anterior part of the scolex there is a bilobed (perhaps ring-like) mass of nervous tissue, from which fibres radiate into the cortex. The second ring commissure in the scolex and the commissure in the vicinity of the excretory vesicle, described as occurring in some Caryophyllaeids, were not observed.

The excretory system comprises about eight chief longitudinal canals lying within the testicular and vitelline zones, but outwardly from the ovary, uterus and cirrus sac. Two laterals on each side are the largest. Numerous connecting

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vessels having a sinuous course are to be seen exteriorly from the longitudinal musculature. The canals apparently form four trunks which terminate in the rather large excretory vesicle lined by cuticle and extending inwards from the extremity of the worm for from .07 to .1 mm. The outer portion is more or less tubular, while the part into which the canals empty, is expanded, measuring from .05 to .075 mm. in diameter. The vesicle may extend anteriorly to lie below the most posteriorly directed loop of the uterus.

The testes are very numerous, .10 to .07 mm. by .04 to .07 mm. in size, lying in the parenchyma at a deeper level than the vitellaria. Five or six are commonly seen both dorsally and ventrally in each trans-section of the body, but they do not extend laterally beyond the main longitudinal nerves, though vitelline follicles are abundant in that zone, as well as above and below the testes. The present species thus differs from most of the described Caryophyllaeids in that the median zone is not free, or comparatively free, from vitellaria. They do not extend as far posteriorly as the latter, though they may reach the vicinity of the cirrus sac, where they may be seen laterally to it as well as to the uterus; nor do they extend quite so far anteriorly, though both testes and vitellaria occur very close behind the broadened portion of the scolex. The testes stain less deeply than the vitelline follicles, and each appears as an elliptical organ with a narrow lining of sperm mother cells, while in the cavity there may be seen little rounded masses of developing sperms.

In mature specimens a large coiled vesicula seminalis is to be seen lying in the middle of the medulla and bounded by the longitudinal musculature immediately anteriorly to the cirrus sac. Its diameter may reach .04 mm. The cirrus sac, which measures about .3 by .23 mm. in a fully retracted condition, occupies a large part of the medulla and is surrounded by the vitellaria, while laterally to its proximal part there may be testes. The organ is overlain distally by the uterus. The wall of the sac contains a comparatively small amount of muscle fibres, as also does the wall of the contained male duct. Fibres traverse the loose parenchyma of the organ. Within the sac, the duct is thrown into a number of coils which are very wide in the middle and proximal thirds of the organ, narrowing in the distal third, this portion being the eversible cirrus. The latter was quite smooth. The male opening, as already stated, may open into the anterior part of the genital atrium, but when the cirrus is more or less everted, the female portion of the atrium comes to open immediately behind its base.

In several specimens the cirrus was seen more or less extended and directed ventro-posteriorly. An everted organ projected .55 mm. from the ventral surface of a worm measuring 4.75 mm. in length, the width in its basal half being .2 mm., at the tip .05 mm. The organ was obviously not completely protruded, its full length being probably .67 mm., about one-seventh as long as the parasite. The basal portion enclosed the cirrus sac with its contained swollen and coiled vesicula, while in the narrower tapering distal half (evidently the true cirrus) the duct was smaller and merely sinuous.

In another instance where the cirrus was partly protruded posteroventrally (.44 mm. long) the barrel-shaped base measured .35 mm. in width, and contained the wide coiled male duct. The genital atrium was displaced posteriorly so as to lie well behind the ovarian isthmus, while the cirrus sac occupied practically all the region ventrally between the ovarian lobes.

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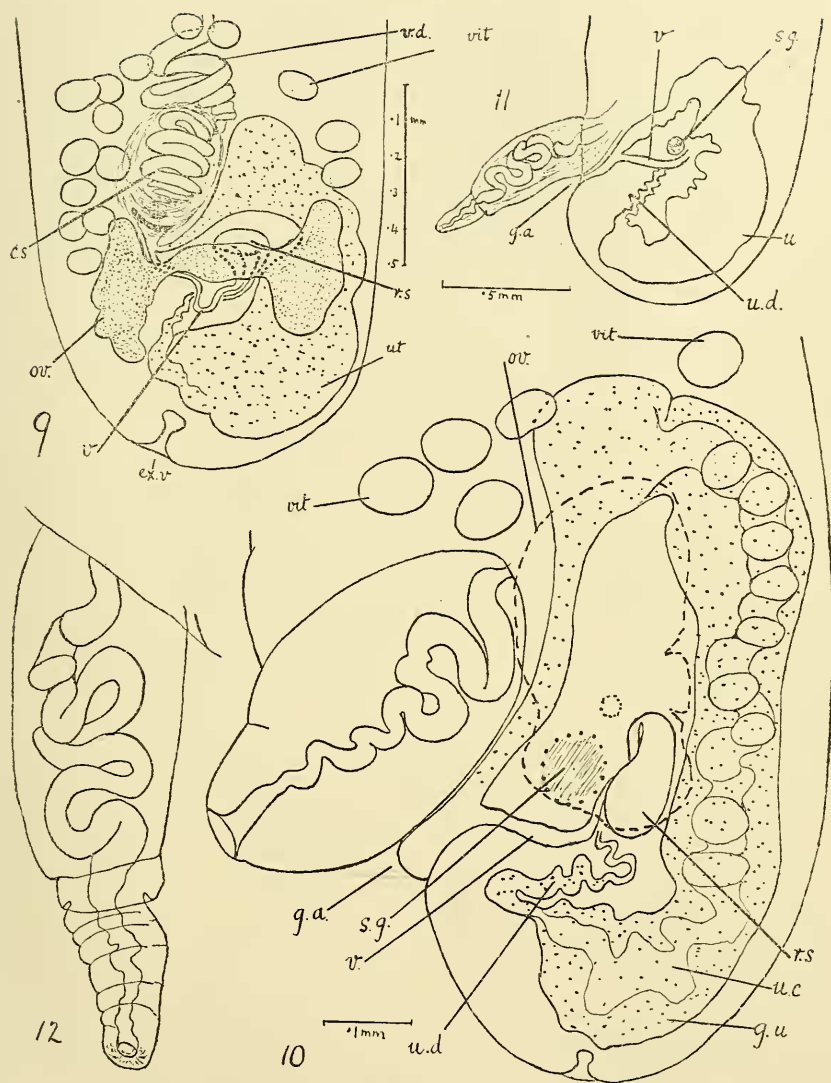
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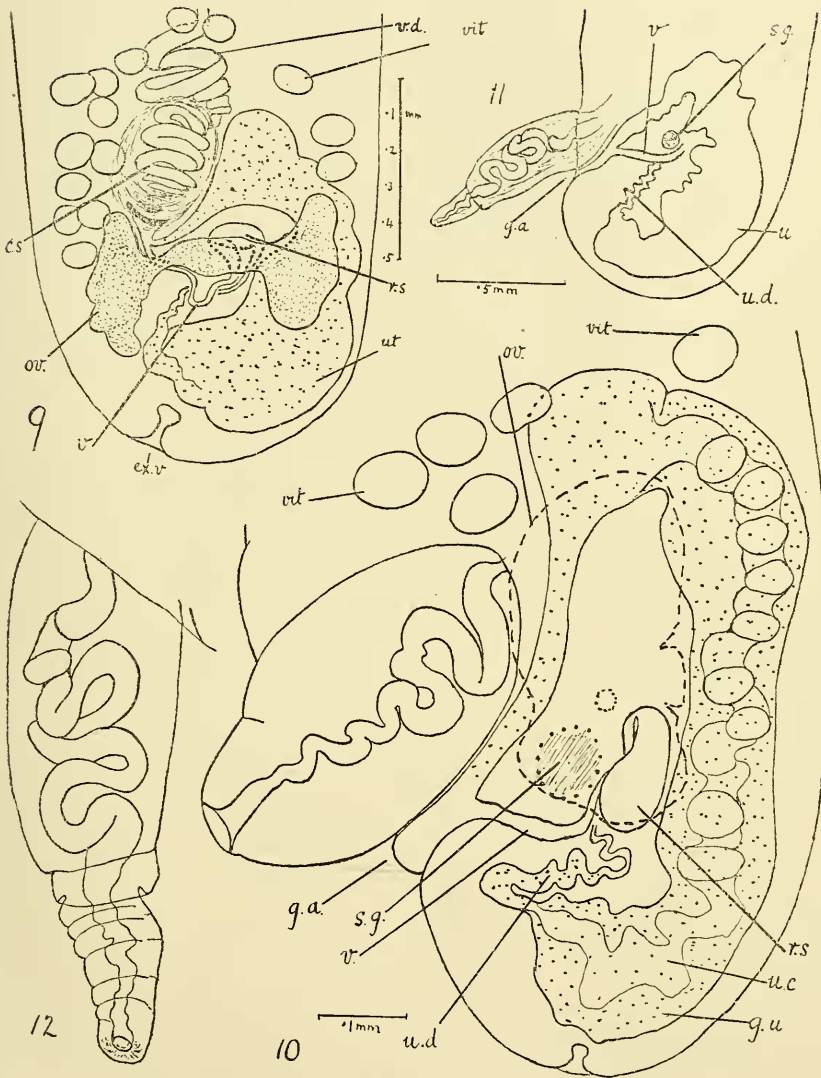
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Figs. 9-12. *Balanotaenia bancrofti*, n.gen. et sp.

9. Posterior end, showing anatomy, viewed ventrally and slightly obliquely: shell gland, vitelline duct, oviduct and also the testes and vitellaria in the vicinity of uterus and cirrus sac are omitted. 10. Lateral views of posterior region, examined in clove oil; showing partly extruded cirrus; outline of ovary and position of commencement of oviduct indicated by broken lines: position of shell gland marked by dots surrounding a shaded area: the thick walls and sinuous lumen of the uterus are indicated. Most of the vitellaria have been omitted. 11. Posterior end of a specimen examined in clove oil: cirrus and sac almost fully extended. Lateral view. 12. Extruded cirrus and sac of specimen figured in Fig. 11—drawn to same scale as Fig. 10.

(For lettering see page 340).



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(For lettering see page 340).

part of the scolex, whereas in other described species of *Caryophyllaeus*, as well as *Glaridacris*, there is a considerable interval behind the scolex free from them. They are very numerous, measure .02 to .035 by .035 to .09 by .04 to .08 mm., and are not restricted to the lateral parts of the parasite, but are also distributed along the median regions ventrally and dorsally. They extend as far back as the anterior part of the ovary, which they may overlie and underlie. They are found above and below, as well as laterally to, parts of the retracted cirrus sac, and also above the preovarian portion of the uterus. The species is characterised by the entire absence of follicles in the postovarian region of the body, thus differing in this respect from every other described species belonging to the Caryophyllaeidae.

Vitellaria at first sight resemble the testes, but usually become more deeply stained. They are, however, readily distinguishable from them, since the constituent cells lying in the middle of the mature follicle are large and contain abundant small deeply-staining rounded granules, more or less peripherally situated, while surrounding the nucleus is a comparatively wide clear zone. The peripheral cells are smaller, and the contents less obviously granular, though the cytoplasm stains more deeply than in the large cells which represent subsequent stages in the development of these yolk cells.

The vitelline ducts were not traceable in front of the ovary, but immediately behind the isthmus they form a fairly wide tubular common yolk duct or reservoir, lying somewhat transversely between the isthmus and the vagina, and immediately below and in front of the shell gland which it penetrates somewhat ventrally and on the left side. In one instance the reservoir measured .1 by .04 mm., but is generally much shorter. It joins the ootype within the shell gland.

The ovary lies in the vicinity of the genital openings, whereas in all other described members of the family it is situated at varying distances between the atrium and the posterior end of the worm. The opening of the atrium in *C. bancrofti* generally lies immediately in front of the isthmus and between the anterior ovarian lobes, while the atrium itself (the vaginal portion of it) passes below the ovary and at times the openings of the uterus and vagina into the atrium may be below the isthmus. The ovary is compact, each lobe being rounded or slightly lobulate and rather narrow, measuring .14 to .4 mm. in length. The general appearance is like that in *C. tuba*. The isthmus is approximately tubular, arched slightly, with the concavity directed dorsally and somewhat anteriorly, and lying in the middle of the worm between the atrium or vagina and the uterus. Above it, or just in front of it, is the receptaculum seminis, while the shell gland is dorsoposterior. An extremely short oviduct arises from it posteriorly and travels slightly dorsally towards the right to become joined by the vagina. This ootype still proceeds posterodorsally, becoming narrow, thin-walled, and surrounded by the cells of the shell gland, and is then joined by the vitelline duct. The ootype is now a narrow uterine duct which travels to the right and posteriorly, becoming thrown into a series of loops lying between the shell gland and the larger succeeding part of the uterus. The shell gland is rounded and comparatively large, measuring about .1 by .1 mm. with a dorsoventral diameter of .07 mm.

The greater part of the uterus lies behind the isthmus, and most of this portion, together with part of the preovarian region, is characterised by the presence of very thick walls composed chiefly of large cells with readily staining cytoplasm. It has been suggested that these are probably glandular. The thickness of the

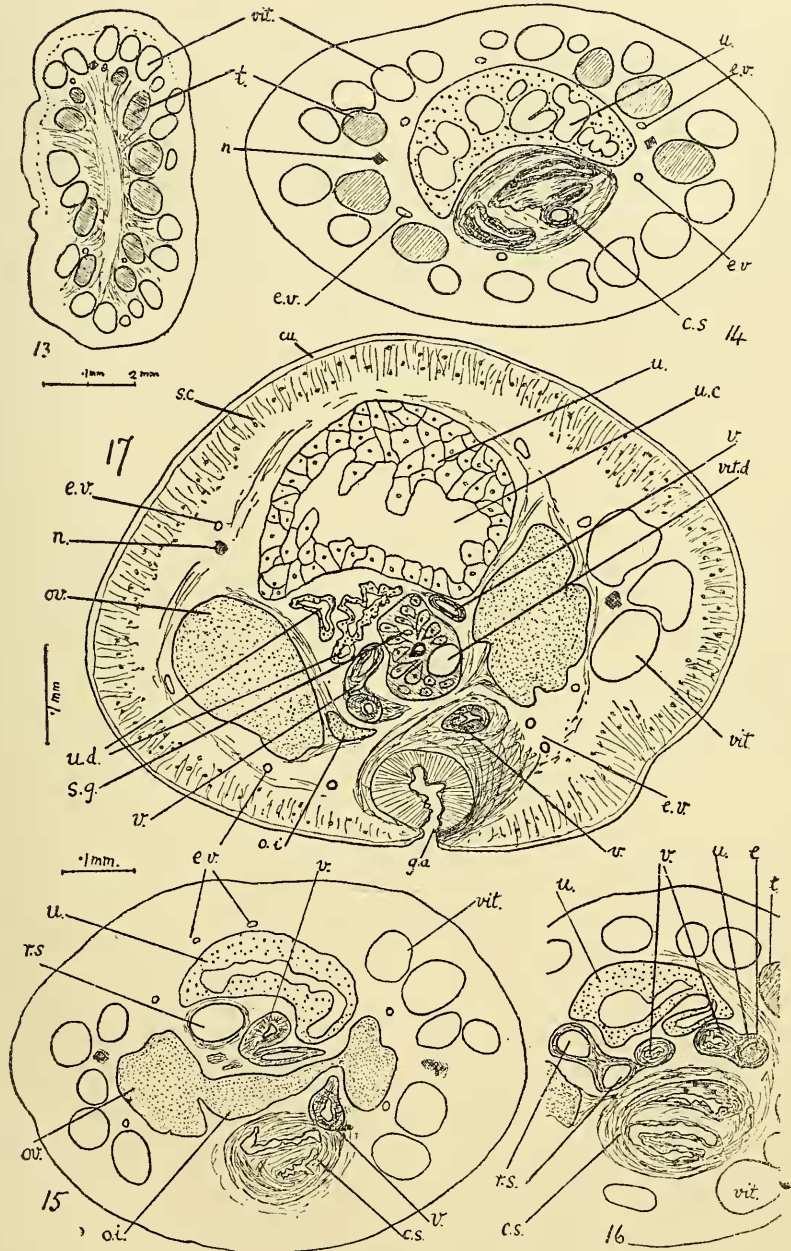
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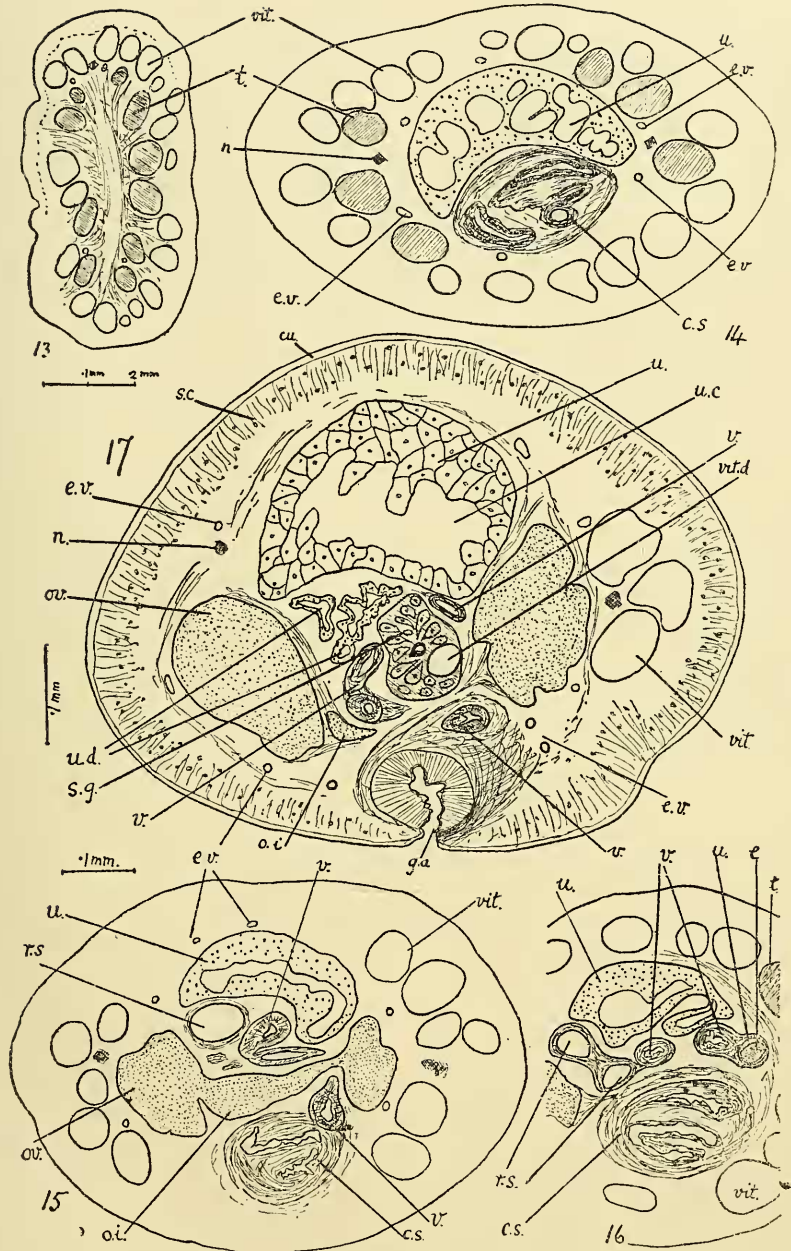
The greater part of the uterus lies behind the isthmus, and most of this portion, together with part of the preovarian region, is characterised by the presence of very thick walls composed chiefly of large cells with readily staining cytoplasm. It has been suggested that these are probably glandular. The thickness of the



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13. Transverse section of mid-region—ventral surface towards right. 14. Section across uterus and cirrus sac. 15. Part of section, behind Fig. 14, showing relation of sex ducts, also junction of vagina and uterus with genital atrium. 16. Section behind 15. 17. Section behind 16, drawn to larger scale, showing opening of genital atrium, also shell gland complex.

Figs. 14, 15 and 16 drawn to scale indicated beside Fig. 15.



Figs. 13-17. *Balanotaenia bancrofti*, n.gen. et sp.

13. Transverse section of mid-region—ventral surface towards right. 14. Section across uterus and cirrus sac. 15. Part of section, behind Fig. 14, showing relation of sex ducts, also junction of vagina and uterus with genital atrium. 16. Section behind 15. 17. Section behind 16, drawn to larger scale, showing opening of genital atrium, also shell gland complex.

Figs. 14, 15 and 16 drawn to scale indicated beside Fig. 15.

wall is often equal to that of the lumen in this region of the organ. Within this thickened tissue the cavity may be thrown into a series of gentle undulations. The uterine duct proceeds posteroventrally to become the "glandular uterus," which, in the vicinity of the excretory vesicle, forms a large loop and then travels forward as a spacious tube dorsally to the shell gland, vagina, ovary and receptaculum seminis. Sometimes this portion lies rather to one side, especially when it contains a few eggs. The tube now becomes thin-walled and widened, assuming a sinuous course and extending forward above the distal portions of the cirrus sac. When the cirrus is extruded the uterus may extend considerably in front of and above the entire sac and above portion of the swollen vas deferens or vesicula. It eventually narrows, bends downwardly and posteriorly between its own ascending limb and the cirrus sac. Its terminal portion is a narrow thin-walled duct, little wider than the breadth of a ripe egg, and ending in the genital atrium which it enters to the left of the vaginal aperture. The uterus thus has a position in the animal quite different from that described as occurring in any other member of the family, and this is correlated with the posterior location of the genital apertures, so that the whole organ has become pushed posteriorly, apparently at the expense of the postovarian vitelline follicles which, as already mentioned, are not represented in this species. The course of the vagina has also become greatly modified for the same reason. The openings of the uterus and vagina into the atrium are both on the left of the median line, the junction occurring in the medulla below the level of the isthmus but above the levels of the distal portions of the cirrus sac, and, as already mentioned, the junction may occur in front of or even behind the isthmus.

The walls of the atrium are thick and lined by cuticle, there being no marked change as it becomes the vagina, while the same kind of tissue surrounds the male aperture as well. The atrium resembles that described for *C. laticeps*.

The vagina travels backwardly, more or less in line with the genital atrium, and lies on the left of the midline, below the level of the ovarian isthmus, turning upwards just in front of the latter, and curving over it near the left lobe. It then becomes thrown into wide loops between the shell gland and the uterus, crossing to the right and then travelling forwards above the isthmus, in the vicinity of which it is sharply bent to enter the rather large receptaculum seminis. The duct is a well-defined tube with relatively thick walls and chitinous lining. The receptaculum is a more or less elliptical organ lying adjacent to the right ovarian lobe and partly or wholly in front of the isthmus and above its level, but below the uterus. It measures .17 by .07 mm., with a maximum diameter of about .08 mm. From its outer end, i.e., on the right side, there passes inwards the narrowed short vagina which joins with the oviduct and soon enters the shell gland. Practically the whole of the course of the vagina is thus behind the ovarian isthmus. In other known Caryophyllaeidae most of its course lies in front of that organ and the tube is not thrown into a pronounced transverse course, but has a longitudinal sinuous one. The presence of a receptaculum has been reported as occurring in only one species of *Caryophyllaeus*, *C. laticeps*.

Eggs are oval to elliptical, measuring .03 to .042 by .025 to .03 mm. The operculate shell is moderately thick and abundantly stippled, probably owing to the presence of a great number of minute processes on its surface. The larval stages are probably passed through in freshwater ciliophores.

The family Caryophyllaeidae at present contains three genera, *Caryophyllaeus*, *Archigetes* and *Glaridaeris*. Four valid species of the first are recognised, all of

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them occurring as parasites of Cyprinidae; *C. laticeps* Pall. (syn. *mutabilis* Rud.) from many genera of Cyprinoid fish in Central Europe; *C. tuba* Wag. from a European *Tinca*; *C. fennicus* Schn. from *Leuciscus* from Northern Europe; and *C. syrdarjensis* Skrjabin from a carp, *Schizothorax intermedius* Gnthr. from Central Asia.

The two species of *Archigetes*, *A. appendiculatus* Ratzel and *A. brachyurus* Mrazek, are both from Central European freshwater oligochaetes. In America the only known member of the family is *Glaridacris catostomi* Cooper of which *Caryophyllaeus larvei* Lamont from the same host species, *Catostomus commersoni* Lep. (also a Cyprinoid) is evidently a synonym. Its locality is Michigan, U.S.A.

The Australian representative which occurs in a Siluroid belonging to the Plotosidae, differs in its anatomy more widely from *Caryophyllaeus* than does *Glaridacris*, so that it seems advisable to separate *C. bancrofti* generically as the type of a fourth genus within the family. The characters of the latter as defined by Luhe and by Cooper require amendment in order to receive the new species, since the presence of a postovarian group of vitelline follicles is not universal in the group.

BALANOTAENIA, n.g. (Text-figs. 1-17).

The new genus, for which the name *Balanotaenia* is proposed, may be characterised as follows:—Caryophyllaeidae; small parasites with anterior end modified to form a scolex devoid of suckers but surrounded by a powerful muscular frill-like expansion thrown into a series of short folds when at rest; genital openings in the vicinity of the ovarian isthmus; vagina largely transverse and mainly postovarian in position; uterus largely postovarian; postovarian vitelline follicles absent. Type *B. bancrofti*, n.sp. from *Tandanus tandanus* Mitchell, Burnett River, Queensland. The type has been deposited in the Australian Museum, Sydney, and paratypes have been donated to the Adelaide Museum.

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